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What have you done for me lately? The fickle alignment of NLP and CALL

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1. Introduction

Natural Language Processing (NLP; or Computational Linguistics, CL; or Language Engineering, LE; or [Human] Language Technology, [H]LT)—which deals precisely with the use of (natural) language by computers—ought to be eagerly brought to bear on the task of developing Computer-Assisted Language Learning (CALL) applications by CALL practitioners.[1]

Similarly, NLP researchers ought to be interested in (human) first and second language learning, and in developing NLP systems in support of language development and learning.

Unfortunately, neither is actually the case. Instead—at least in the eye of the casual beholder—the two disciplines seem to live in completely different worlds. In the next section, I will try to make this statement a bit more concrete, and in section 3, we will discuss some of the reasons that can be inferred to lie behind this state of affairs. In section 4, I will say something about my own views on the matter, including how the current situation could be improved, and in section 5 I will try to draw some general conclusions and venture some recommendations for the future.

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[1] In this paper, I will not discuss Speech Technology at all. This field is normally included when we use the terms LE or (H)LT, but normally excluded if we say CL or NLP. My own background is in CL (and in languages), and I simply lack the necessary qualifications in Speech Technology to say anything meaningful about it in the context of the issues that I wish to bring up here. However, Speech Technology seems to have had a greater commercial impact than NLP on the CALL field (see e.g. Pennington and Esling 1996; Carlson *et al*. 1998; Chun 1998; Eskenazi 1999; Gupta *et al*. 2000).

2. NLP and CALL: oil and water?

2.1. The view from NLP

In the recent broad *Survey of the state of the art in human language technology* (Cole *et al*. 1996), there is not a single word about (human) language learning.[2] Similarly, CALL contributions to the biennal international conference on computational linguistics (COLING) have been next to nonexistent (e.g. Pulman 1984; Borissova 1988; Schwind 1988; Menzel 1988, 1990; Zock, Sabah and Alvise 1986; Zock, Frankopoulo and Laroui 1988; Zock 1996; Schneider and McCoy 1998). Thus, while certainly not part of the core of NLP, CALL seems not to have a place even in its periphery. A recent survey conducted by the author of the use of NLP technology in computer-assisted learning of Nordic languages turned up similar results: There were some fledgling attempts to combine NLP and CALL, but most CALL applications in this area are NLP-free, and most NLP work on Nordic languages has nothing to do with CALL (Cerratto and Borin 2002).

Much of the work on using NLP in CALL has been pursued under the heading of *Artificial Intelligence* (AI; a field which overlaps minimally with mainstream NLP; see Swartz and Yazdani 1992; Holland *et al*. 1995), particularly in the area of *Intelligent Tutoring Systems* (see Frasson et al. 1996; Goettl *et al*. 1998).

2.2. The view from CALL

The power of CALL (Pennington 1996), which, according to the back cover blurb, "provides an up-to-date and accessible view of the field of Computer Assisted Language Learning" and "is destined to be the standard reference on CALL and the textbook of choice for teacher training courses covering the use of technology in language learning", contains basically nothing on the uses of NLP in CALL.[3]

Chapelle (1997, 1999, 2001) is not optimistic about the contributions of AI/NLP to CALL, although at least in her 2001 book, the NLP work that she reviews (under the headings "Artificial intelligence" and "Computational linguistics"; 2001: 32–36)—about ten general works on AI and CL, and about double that number of works on ICALL—is in most cases more than a decade old, and sometimes more than two decades, in a field which has seen very rapid development in the last ten years. Levy (1997) is a bit more optimistic, but the picture he paints of the state of the art of AI and NLP (1997: 57–65) is not markedly different from Chapelle's.

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[2] At least, there is no mention in the index of the book of "CALL", "(second or foreign) language learning", etc., and no section headings indicating a topic connected with (human) language learning.

[3] But there is a chapter on Speech Technology in CALL (Pennington and Esling 1996) and one on concordancing (Flowerdew 1996).

2.3. All is not gloom?

On a more positive note, there have been some international workshops on NLP and CALL, sometimes in connection with CL conferences (e.g. Jager *et al*. 1998; Olsen 1999; Schulze *et al*. 1999; Efthimiou 2000), although these, too, seem to depend on fortuitous circumstances, rather than a conviction that CALL is an important application area for NLP; thus, the *Language resources and tools for educational applications* workshop held at the previous *International Conference on Language Resources and Evaluation*, LREC 2000 (Efthimiou 2000), will not be repeated at the upcoming LREC 2002.

The ICALL bibliographies of Bailin (1995)—containing exclusively works on ICALL—and Heift and Schulze (n.d.)—with works relevant to ICALL—contain about 200 entries each. There is some overlap, but less than 50 per cent.[4]

2.4. Summing up

The overall impression one gets going through the literature on the use of NLP in CALL is that this is not a recognized research area.[5] Rather, the endeavors that we do come across to integrate NLP in CALL applications seem to be the fortuitous results of individual researchers here and there being interested enough in the combination, and knowledgeable enough in the field of NLP or CALL—as the case may be—to make the effort despite the lack of an established tradition, and the general lack of interest among mainstream practitioners in the respective fields. In the next section, I will try to say something about the reasons for this state of affairs, which I believe largely boils down to cultural differences.

3. A digital divide?

Some factors that could have been instrumental in fostering the attitudes in the two communites (NLP and CALL) toward each other are:

- *different cultures*
- *misunderstandings about the other discipline*
- *language-learning ideology*

I will treat each of these in turn in the following subsections.

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[4] This is to be contrasted with the CL literature recently scanned for phase 1 of the *Digital Archive of Research Papers in Computational Linguistics* (details are found at <http://www.aclweb.org/>) covering 39 volumes of conference proceedings (*ACL*, *ANLP*, *EACL*, and *TINLAP*: 2,100 papers, 13,000 pages) from the years 1978–2000. The journal *Computational Linguistics* and *COLING* proceedings will be included in phases 2 and 3, respectively.

[5] Even though it does have a name: *Intelligent CALL* – ICALL. Some researchers reserve this name solely for what Gupta et al. (2000) and Schulze (2001), among others, call *parser-based CALL*. There are other kinds of NLP technologies than parsers, however, so in my view, the term ICALL could well be used in the wider sense of "CALL incorporating NLP technology or technologies".

3.1. Different cultures

NLP researchers often come from a Computer Science background, or from General Linguistics, while CALL researchers tend to have their basic training in Languages or Applied Linguistics. It is well-known that these fields are characterized by quite different concerns about relevant study objects, research methodology, etc., in short, what is worthwhile investigating and how best to go about investigating it. Sparck Jones (1996) remarks, in a slightly different context: "It has also to be recognized that the arrogance so characteristic of those connected with IT – the self-defined rulers of the modern world – is not merely irritating in itself, it is thoroughly offensive when joined to ignorance not only of language, but of relevant linguists' work" (1996: 13), and: "On the practical side, it is impossible not to conclude that many linguists are techno- and logico-phobes." (1996: 13f).

There is a tendency for both computer scientists and formal linguists to treat language as a thing, an object both separable and separate from any of its uses. This is arguably the ultimate assumption underlying formal grammars and logical semantics, where language is seen as a kind of formal symbol game. On this view, NLP equals symbol processing. However, many linguists feel that language and its concrete uses cannot be separated, and that "language and culture always go hand in hand – they are for all intents and purposes inseparable" (Östman 2000: 39).

The NLP and CALL 'cultures', too, go hand in hand with their respective 'languages', so it is perhaps not surprising that there may be miscommunication between them.

3.2. Misunderstandings about the other discipline

In section 2 above, I mentioned that the recent book on *Computer applications in second language acquisition* (Chapelle 2001),[6] as well as the older overview by Levy (1997) both present the state of the art in NLP as that found in book-length works published in the beginning of the 1990s or earlier. Now, these works—being textbooks or summaries of original research carried out at the latest a few years before the publication of the books in question, actually reflect the state of NLP of around 1985. Thus, even though the claim that NLP is not good enough for serious CALL applications may be true, this does not follow from the works adduced by Chapelle (2001) as representing the abilities of the field, since they were not, in fact, representative of the state of the art in the year 2001 (for which see section 4, below).

On the other hand, Chapelle has a point when she says that "In Computational [L]inguistics, [t]he primary question is[:] How can rules of language, and language processing be used to write computer programs to recognize and produce human language?" (1999: 109), implying that NLP is not primarily concerned with *language use* (cf. the preceding subsection), while this is the *de facto* main concern in SLA research.

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[6] The subfield of (applied) linguistics concerned with non-native language learning is most widely referred to as *Second Language Acquisition* (SLA), covering both second and foreign language learning.

3.3. Language learning ideology

The emphasis in the SLA community is on communicative language learning. This is often interpreted as excluding e.g. form-based drill, which is where the greatest potential would be for present state-of-the-art NLP. However, at Uppsala University, there are at present regular courses in more than 40 languages, many of which have extremely complicated and exotic grammatical systems compared to the so-called 'Modern Languages', at the same time as the number of student contact hours is limited to 3–5 hours per week. Herein lies a great, mostly untapped, potential for NLP in CALL, as also in the support for threatened languages (Reyhner *et al*. 1999; Allwood and Borin 2001; Borin forthcoming).

We would do good to remind ourselves, too, that there are many kinds of language learning, and language learning situations, and not all of them conform to the face-to-face interaction ideal implicitly or explicitly espoused by advocates of communicative language learning,[7] e.g.:

- the learning of written standard languages (both second/foreign and native)
- the learning of dead (classical or liturgical) languages
- learning situations with few contact hours in the case of languages with very complex morphologies, e.g. learning Hungarian at a Swedish university
- the learning/revival of moribund, 'almost dead' languages, where there are few native speakers, and possibly no educated teachers
- languages for special purposes (LSP), e.g. learning to read scientific texts on Geology in Russian
- learning of Linguistics or Computational Linguistics, where grammar is an object of study in its own right (Saxena and Borin forthcoming), as well as algorithms for NLP (de Smedt *et al*. 1999: 112ff)

4. NLP and CALL: milk and honey!

Knowing the state of the art of NLP, can we say what areas seem promising and mature enough for the purpose of developing interesting CALL applications?

By implication, NLP use in CALL is equivalent to what Gupta *et al*. (2000, section 6) call "parser-based CALL", which in turn, as I have already mentioned, is frequently taken to be the same as "Intelligent CALL". But modern NLP encompasses much more than rule-based grammatical analysis of language (this being one reasonable interpretation of "parsing" in NLP). In addition to its traditional strong ties with (General) Linguistics, on the one hand, and (Theoretical) Computer Science, on the other, modern NLP overlaps considerably with disciplines such as Information Retrieval (IR)—thereby defining the NLP subfield of *Information Refinement* (Olsson 2002), which

[7] Against Chapelle (1997) with her insistence on face-to-face interaction research as the paradigm for computer-assisted second language acquisition, Salaberry (1999) and Harrington and Levy (2001) point out that the computer-mediated communication (CMC) so important in CALL in fact is different and needs to be investigated on its own terms.

includes at least *Information Retrieval*, *Information Extraction*, *Cross-Language Information Retrieval*, *Text Segmentation*, and *Automatic Summarization*—and Human-Computer Interaction (HCI). Further, corpus linguistics in its NLP variant—sometimes called *Empirical NLP*—i.e., an approach to NLP problems strongly informed by information theory, (mathematical) statistics and machine learning research (see Manning and Schütze 1999)—has been a dominant theme in NLP for the past decade.[8] A related trend has been the focus on the creation of large-scale reusable linguistic resources, with concomitant work on standardization of formats and annotations,[9] general NLP tools and evaluation of resources and tools. This work has been done in the framework of organizations and initiatives such as LDC (*Linguistic Data Consortium*; <http://ldc.upenn.edu/>), ELRA (*European Language Resources Association*; <http://www.elda.fr>), EAGLES (*Expert Advisory Group on Language Engineering Standardization*; <http://www.ilc.pi.cnr.it/EAGLES/>), and since 1998, there is a biennal international conference series devoted to these matters, the *International Conference on Language Resources and Evaluation* (LREC; LREC 1998 took place in Granada, LREC 2000 in Athens, and LREC 2002 will be in Las Palmas).

Against this background, we can tentatively identify some possible applications for NLP in CALL, which I will discuss in the following subsections, making up a non-exhaustive list of such applications.

4.1. Text selection for reading in a second language

Techniques from NLP and IR can be used for selecting appropriate (with respect to language, subject matter and difficulty) reading matter for second language learners. Nilsson and Borin (forthcoming) describe a prototype Web search application for retrieving such text material for teachers and learners of Nordic languages.

Somewhat more speculatively, text classification/segmentation (see e.g. Hearst 1997; Heinonen 1998; Choi 2000; Choi *et al*. 2001) can be used for hypertext generation from existing documents. This is research that we are pursuing in the PLeaSe • PALaTe subprojects of PADLR, but for the more general purpose of making large text materials more accessible to Humanities students. We still have to look into the more specific issue of creating appropriate hypertext for language learning.

Finally, and much more speculatively, automatic summarization or (more likely) machine translation techniques could be used to produce adapted text material from existing texts which are unsuitable for some reason (too long, too difficult, etc: cf. the 'easy readers' sometimes used in language teaching).

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[8] By contrast, most of the corpus linguistics that has found its way into CALL—used for, e.g., so-called Data-Driven Learning—is of a different kind, much more dependent on manual analysis by linguists (see Borin forthcoming).

[9] Although, again, there is little communication between the standardization bodies working on NLP standards and those working on standards in the area of e-learning systems and applications (e.g. IMS <http://www.imsproject.org>, and IEEE LTSC <http://ltsc.ieee.org>), meaning that the intersection of NLP and e-learning, containing among other things ICALL, is probably not given due consideration in this work (see Borin in press).

4.2. Parser-based CALL and its relatives

Parser technology has progressed considerably in the last decade, although this has happened mainly with other kinds of parsing systems than the traditional PS grammar-based symbolic parsers.[10] Instead, we now find so-called partial parsers or chunkers (Abney 1996; Tjong Kim Sang 2002), and cascades of such parsers (Brants 1999), both parsers using hand-written rules and parsers that are trained by e.g. transformation-based learning (Brill 1995; Lager 1999), and probabilistic parsers (see Miller *et al*. 2000) . Parsers perform better now than they did ten years ago. Whether they are now good enough to be allowed to correct language learners' free production is a moot point.

One technology that we in the CrossCheck group and others have started looking into is what we tentatively call *Writing Memory* (or perhaps *Example-Based Writing*), where the idea is to use techniques similar to Translation Memories or Example-Based Machine Translation (see Brown 1999, 2000, 2001) for the monolingual case of language learners striving to master a particular target language genre in writing.[11]

4.3. Tools for teachers

Even if parsing technology, or grammar checking technology is still not good enough, so that it we would not want to expose learners directly to their infelicities, in the form of missed errors, misclassifications of correct language as errors, and faulty diagnoses of errors (i.e., inappropriate feedback), we can still imagine how they could be useful to language *teachers*.

If we take the case of grammar checkers, there are some indications that experienced writers tend to ignore correction suggestions provided by grammar checkers, but are helped by having potential errors highlighted for them (Knutsson 2001: 174). Analogously, teachers—being expert users of the language—correcting essays or free-form test answers could be helped by having potential errors highlighted in the text, even though they would have to formulate feedback themselves, which could free some of their time for more interesting teaching tasks.

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[10] In an earlier WGLN-funded Swedish Learning Lab project, *Digital Resources in the Humanities* (DRHum), we experimented with letting CL students produce a computational grammar for medical student – simulated patient dialogs, with promising results (Andersson *et al*. forthcoming; Gustavii *et al*. forthcoming). The grammar writing workbench – parser combination used was the LKB System (Copestake 2000), using a form of HPSG (Sag and Wasow 1999).

[11] Strictly speaking, in this case the category "language learners" includes also native speakers learning to write a standardized written form of their native language, which arguably is a form of foreign language learning. For a similar application to 'Example-Based Writing', but in a bilingual setting, see Narita 2000.

4.4. Learner language research, learner modelling, and learner interaction

Text material produced by second language learners has been collected (on paper) for a long time, and used as the empirical basis of so-called 'error analysis' and investigations of so-called *interlanguage*. For the same purposes computerized corpora are extremely interesting, because of the much more varied investigations of interlanguage in large collections of learner language production—or *learner corpora*—made possible by the use of automatic—hence consistent—corpus annotation and analysis tools, compared to the tedious, error-prone, and often inconsistent manual analysis, which as a rule will spot *errors*, but not *tendencies*, such as systematic *overuse* or *underuse* of lexical items or grammatical constructions in the learner language, compared to native production (Granger 1998). Here, NLP techniques such as part-of-speech taggers (Borin and Prütz forthcoming) and parsers can be utilized to systematically investigate learner language in different stages for learners having different backgrounds. In this way, we will hopefully arrive at better models of language learners and language learning, which together with the same kind of NLP analysis tools in CALL applications, have the potential to provide greater personalization in feedback and in the 'default' learning path offered by a CALL system (which can be dynamically tailored to the individual student).

4.5. Authoring tools

Finally, we will mention the ongoing trend in NLP toward reusability of language resources and processing resources. One aspect of this trend is the appearence of NLP workbenches, or platforms, either for general NLP tasks, as in the case of GATE (Cunningham 2002) and Ellogon (Petasis *et al*. in press), or for more specific purposes, such as the KABA platform for Information Refinement (Olsson 2002). Davies (2000) laments the lack of simple (yet powerful, one assumes) authoring tools for CALL, and Chapelle (2001: 170ff) offers a list of "[n]eeds for CASLA [Computer Assisted Second Language Acquisition] authoring tools". She does not mention support for NLP applications specifically among the needs, but out of the functions that she lists as desirable in an authoring tool ("Estimate task difficulty", "Analyze learners' linguistic output", "Analyze the language of objects (written, text, audio, video)", "Support objects ordered in a database", "Gather process-oriented data", "Support a structure for a learner model", "Author learning conditions"; 2001: 171), most are such that they could include an NLP component.

In view of the current trend toward reusability and standardization of NLP resources, now would be the right time to initiate work on a platform—or at least a modular toolset—for the development of NLP-based CALL applications. A first step would be to define the needs (as Chapelle 2001: 170ff) or use cases (as Olsson 2002 for KABA), for such a platform or toolset.

5. Summing up and looking ahead

Technology tends to creep up on us, and this is something that we should take into account when discussing the role of (a particular) technology in some established practice.

When we say that e.g. CALL should not be technology-driven, what do we mean? Do we mean that we should have waited for language teachers, in the 1930s, say, to imagine something like computers, and how good it would be to have these computers in the language classroom? New technologies are often adopted for uses not foreseen by their creators, and the new use of the technology contributes to shaping the practice in which it is used.[12] This is a very powerful mechanism of change, but even more powerful is the process whereby adopters of a technology learn to understand how the technology works, and how to modify it to suit their needs better. This is basically how agriculture evolved out of a hunter-gatherer economy in Western Eurasia about 15,000 years ago, and according to one scholar (Diamond 1998), this single event was the prime mover of the development which led via the Industrial Revolution to the Information and Communication Technologies that are the essence of both CALL and NLP. In my view, we want to be agriculturalists, rather than hunter-gatherers, when it comes to the stance we should take with respect to technology in education.

Our everyday technologies change incrementally and imperceptibly (as do we ourselves, of course), but special technologies do as well. Visiting a hospital today is markedly different from just 20 years ago—at least in the industrialized West—in terms of the technology we are likely to encounter, but chances are that we have taken the differences in our stride, as it were, because they did not occur all at once. However, you do need to go to a hospital every now and then (or work in one) in order to be aware of the development and of what the current possibilities are. In the same way, you need to keep up with developments in e.g. NLP, which have been extremely rapid in the past decade, in order to be able to make an informed assessment of their usefulness for e.g. CALL applications. This keeping up is best done not by accessing popular accounts of NLP, or book-length works published long after the research was done, but by going straight to the research papers published in professional journals and conference proceedings.

Consequently, whoever wishes to utilize NLP technologies in CALL applications should ideally be trained to understand the technologies, i.e., trained in Computational Linguistics or the equivalent, as we have not yet advanced to the point where these technologies come prepackaged for immediate use (see section 4). Of course, you must also know the needs of language learners and teachers, or you will invent solutions to nonexistent problems, and fail to provide solutions to the existing ones. This is basically the position of Davies (2000), although he talks about "programmers" rather than

[12] Refusal to acknowledge this is tantamount to the following 'Noble Savage' kind of fallacy: "This example demonstrates America's fascination with Native languages and history. According to the dominant cultural coding, Native languages and cultures are located in the historical past, while English language and culture are associated with a technological future. To be an authentic Native is to be an immutable part of history." (McHenry 2002: 103)

"computational linguists". With Davies, and contrary to Amiri (2000), I do not believe that (language) teachers should become programmers.[13] On the other hand, against Davies, I do not believe that it is realistic to demand that "linguists who need to communicate with programmers ought to understand the way programs work" (Davies 2000: "Lesson No. 6: Doing it yourself is not the answer"), nor that the ideal CALL project team would consist of a linguist and a programmer (in our case a language teacher and a computational linguist). As the understanding of the way NLP systems work should be quite deep to be useful, in my view, I think a possible solution is rather to be found in the way Computational Linguistics is taught in some places, following the realization that bringing linguists and computer scientists together was mostly not the optimal way of approaching NLP problems. Hence, at some universities, Computational Linguistics is taught in the form of study programs comprising both General Linguistics and Theoretical and Applied Computer Science. These programs—in Sweden typically three to four years in length—thus produce a kind of *mediators*, who have both a good understanding of the kinds of problems linguists are interested in and the conceptual apparatus in which these problems and their solutions should be framed in order for linguists to understand them, and the same kind of understanding of the field of Computer Science, without however being on a par with experts in these fields. This makes them ideally suited for assuming a mediating or coordinating role in NLP projects. The same kind of solution could work both for computer-assisted learning in general, and for ICALL in particular.

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[13] The reason I do not agree with Amiri is, briefly, the following. While it is perhaps true that "modern visual programming environments have turned programming into more of an art than mathematics" (Amiri 2000: 81), the fact of the matter is that here, as elsewhere, the underlying fundamentals tend to change more slowly than their outward manifestations. There is a way of thinking, of approaching problems and solving them, that all good programming courses try to convey to students. It involves, among other things, a thorough knowledge of algorithms and data structures, plus the notion of programming paradigms. When this knowledge is securely in place, the actual programming language used becomes a secondary concern. Amiri uses car-driving as the metaphor for programming; I would personally use another one, such as e.g. carpentry or interior decorating. But even if we stick to the car driving metaphor, we all know that, although many people drive cars, we put higher demands upon professional drivers, and this is an important component of the metaphor. If we are to train language teachers in programming, our aim should in my view be to make them professional in their programming, because in that way, there is less risk of their fruitlessly repeatedly reinventing inferior kinds of wheels, simply because they do not recognize their particular problem as an instance of a more general class of problems, or they do not know where to look for solutions to their problem, or how distinguish between a better and a worse solution, etc.

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